

# Moments of multiple scattering signatures in a stochastic ensemble of drops

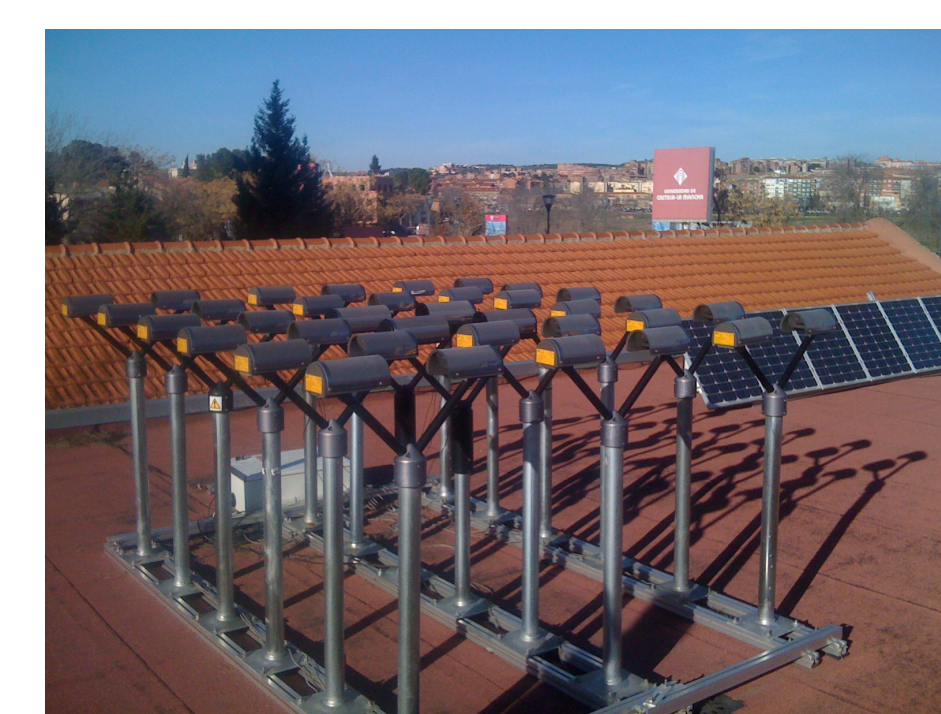
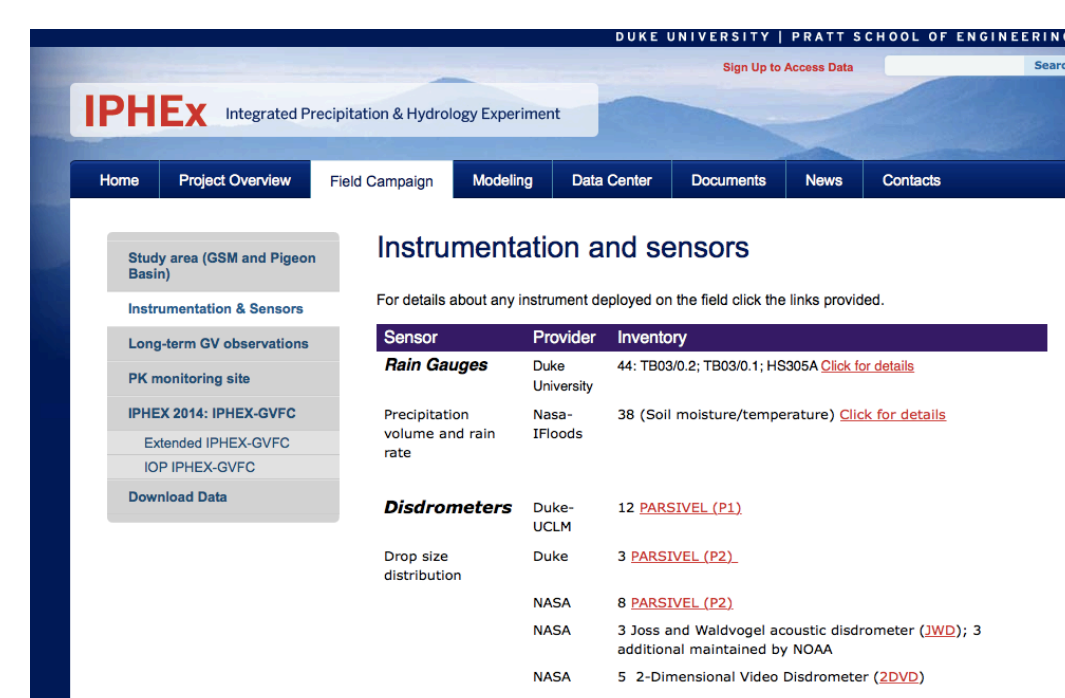
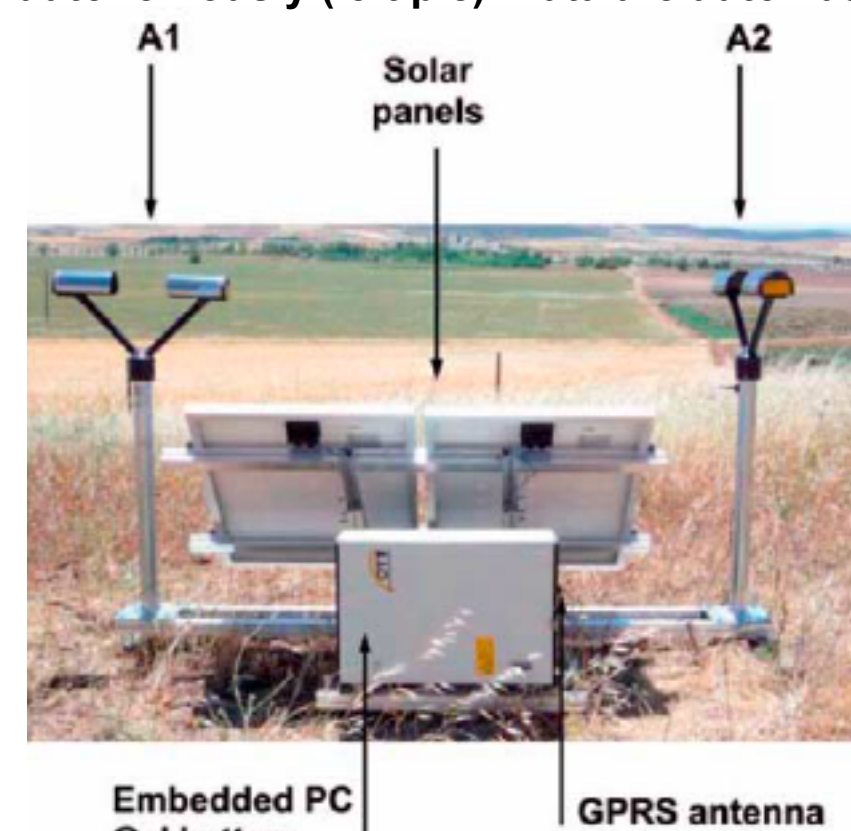
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Laser disdrometers provide a sample of the rain drop size distribution (RDSD) of precipitation. This sample is built over a 2D+time slice, with the extra dimension corresponding to the accumulation time. The time-integrated slice is deemed as a suitable representation of precipitation within a large 3D box around the instrument (assuming that the spatial correlation of precipitation decreases only moderately with distance). However, a unique 2D+time RDSD corresponds with many actual 3D distributions of the rain drops. Each spatial configuration is equivalent to any other in terms of the RDSD function, but it is not in terms of radiometric characteristics, both near and far from field, because of multiple scattering. Here, using the T-matrix formalism, we investigate the radiometric differences for two ensembles, 10 minutes apart, for about 50 different 3D configurations stochastically-derived from two measured RDSDs, with 30 and 31 drops respectively.

## INSTRUMENTS [UCLM DISDROMETER SET]

The UCLM has been maintaining a network of 16 disdrometers since 2009. They were cross-calibrated (right pic), and then sent to Duke Univ. to participate in the IPHEX experiment (middle pic). The original setup of the instruments consists in a dual arrangement with a solar panel and two batteries, so the set can work autonomously (left pic). Data are automatically sent to a server every minute, and then filtered and processed to standard accumulation periods (1, 5 and 10 min).

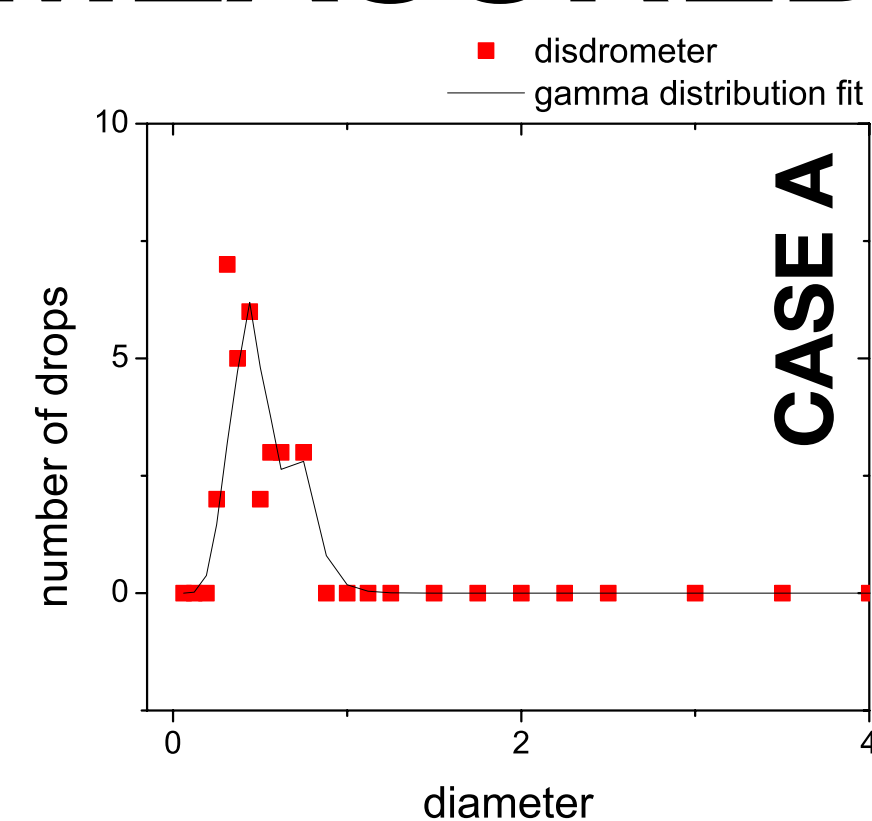


The UCLM disdrometer array is made of 16 Parsivels

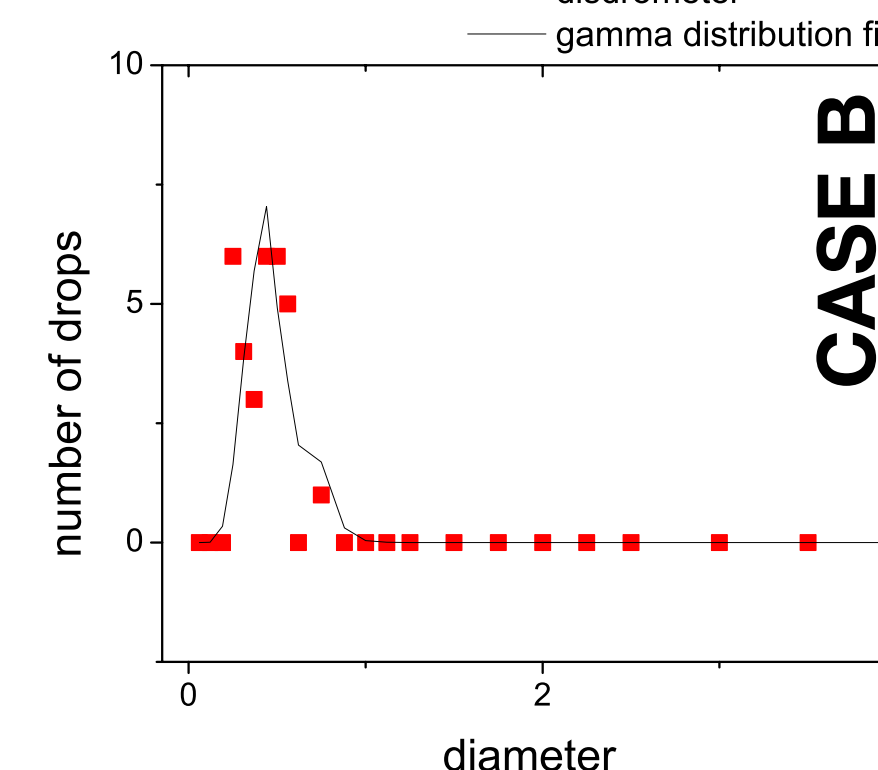
An X-band radar (Meteor 60X) and a few more Parsivel-2 will be available in early 2016

## MEASURED, BASE RDSDs [10 min interval]

The number of drops is 30. The gamma distribution fit is shown. The number of drops is small on purpose.



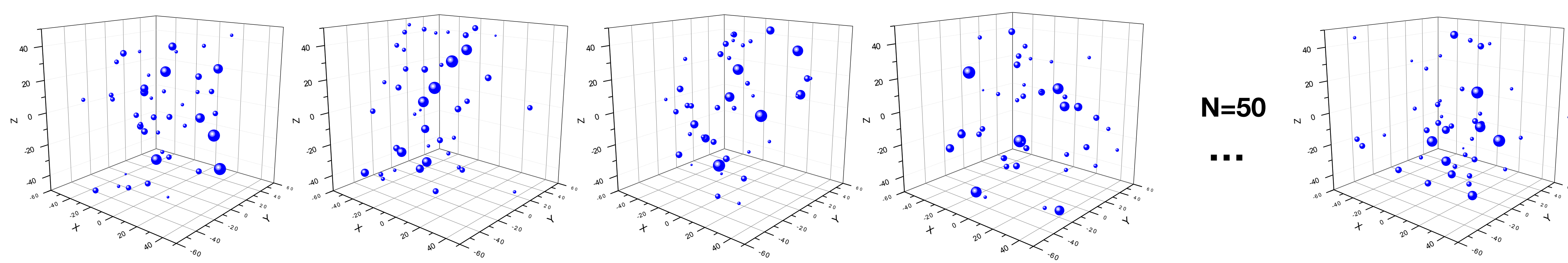
➔ 10 min later ➔



The number of drops is 31. The gamma distribution fit is shown.

## EQUALLY-LIKELY 3D CONFIGURATIONS FOR THE SAME DSDs

The 10-min RDSD were used to derive 3D configurations of non-interacting drops. Drops are assumed to be spherical for simplicity; more complex geometries will only reinforce the point made –that is, that uncertainty arises because of the actual spatial configuration of the RDSD due to multiple scattering–. The plots below are for another DSD in the database [diameters are exaggerated].

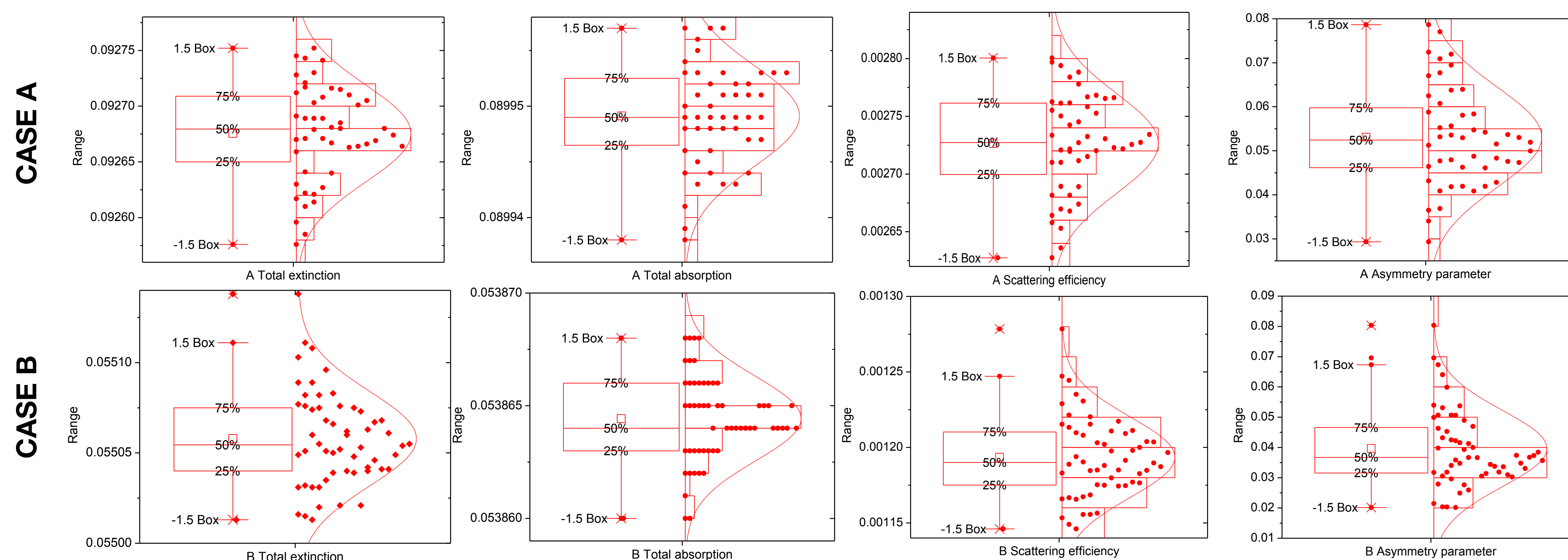


We made sure that the realizations of the two ensembles were truly random

## T-MATRIX-DERIVED RADIOMETRIC CHARACTERISTICS FOR THE TWO ENSEMBLES [5 °C, X-band]

We ran the T-matrix (v. 3.0) code for the members of the two ensembles, for X-band wavelength. Processing time varied (typically, about 72 hours). Temperature was set 5 °C. We then calculate the spread of the radiometric parameters, and cross-compared the estimates. The results show some spread, especially in the asymmetry parameter.

### SPREAD OF THE TOTAL EXTINCTION, TOTAL ABSORPTION, ASYMMETRY FACTOR, AND SCATTERING EFFICIENCY



The plots of the spread correspond with 48 ensemble members. It takes about 72 h to run each one of the 3D configurations through the T-Matrix code

The plots of the spread correspond with 56 ensemble members. It takes about 80 h to run each one of the 3D configurations through the T-Matrix code